SECTION 16123--FIBER OPTIC CABLE INSTALLATION

PART 1--GENERAL

WORK DESCRIPTION: The Subcontractor shall furnish, install, terminate, and test optic cables as shown on the drawings and described in this specification.

WORK INCLUDED: The Subcontractor shall provide all qualified labor, tools, materials needed to complete the installation, termination, and testing of the fiber optic cable. This shall include the connections at all patch panels. The Subcontractor shall ensure that the signal loss is less than the maximum allowed.

The Subcontractor shall submit a test procedure for testing all fiber optic cables within this project for review and approval prior to use.

The Subcontractor shall ensure that the use of the installation devices and test equipment is operated as directed by the equipment manufacturer. Verification of training on the instrumentation to be used in the installation, termination, and testing of the fiber optic is required to be submitted to the Contractor. Fiber optic cable installers will be required to provide evidence of a current BICSI Installer level certification or approved equal. All Subcontractor personnel splicing, terminating and testing fiber optic cable will be required to provide evidence of current BICSI Technician level certification or approved.

QUALITY CONTROL:

Codes and Standards:

The latest edition of the document in effect on the date of invitation to bid shall apply to the work described herein. In the event of conflict between the documents referenced and the contents of this Specification or the Drawings, this Specification and the Drawings shall govern.

Electronics Industry Association (EIA)

EIA - 440	Fiber -optic Terminology
EIA - 445	Standard test procedures for fiber-optic fibers, cables, transducers, connecting and terminating devices
EIA - 458	Optical waveguide material, classes, and preferred sizes
EIA - 475	Fiber-optic connections - generic specifications
EIA - 509	Fiber-optic terminal device - generic specifications

Components and installation shall comply with applicable requirements of the Electronics Industry Association (EIA) Standards EIA-440, -455, -458, -457, and -509 pertaining to optical-fiber cable and system component construction and installation. The fiber optic cable installation shall conform to the standards for fiber data digital interface.

SUBMITTALS:

See Vendor Data Schedule.

Product Data: The Subcontractor shall submit catalog cut sheet which show as a minimum the complete operating specification of all items to be purchased under the requirement and all instruments which will be used in the installation and testing of the fiber optic cable.

PART 2--PRODUCTS

GENERAL:

Furnish all labor, materials, equipment and appliances required to complete the installation of the complete fiber optic communication system. All labor, materials, service, equipment, and workmanship shall conform to the applicable chapters of the National Electrical Code NFPA 70, the National Electrical Safety Code (NESC), and fiber distributed data interface (FDDI).

MATERIALS:

The fiber optic cable shall be Siecor cable part number 022 K81-31141-00 or approved equal. The fiber optic cable shall meet the following specifications:

The cable shall have 22 fibers. The fiber shall be 62.5/125 micron, 0.275 NA, graded index, which meet the following requirements:

The fiber core diameter shall be 62.5 +/- 3 micron glass. EIA 455-58 shall be used as the overall guide for this measurement. One of the following shall be used for the measurement:

a. EIA 455-29 (Transverse Interference)
b. EIA 455-43 (Near Field)
c. EIA 455-44 (Refracted Ray)

The fiber cladding shall be 125 +/- 3-micron diameter glass measured in accordance with EIA 455-55 or -48.

The fiber shall be coated with a mechanically stripable coating.

The fiber shall be proof tested to ensure minimum tensile strength. The minimum tensile load shall be 800 lbs.

Each fiber shall be uniquely marked. This may be a color code or a numeric marking at least once per foot of length.

Crush resistance of the cable shall be equivalent or greater than 250 pounds per inch.

The fiber attenuation shall be such that the cabled fiber attenuation coefficient shall be within the range of:

2.8 to 3.75 dB/Km at 850 nm
0.8 to 1.5 dB/Km at 1300 nm

This shall be tested in accordance with EIA 455-56 (Cut Back Method) over the temperature range of 0 degrees Celsius to 70 degree Celsius.

There shall be no localized attenuation greater than 0.2 dB as specified in accordance with EIA-59.

The bandwidth (Information Transmission Capacity) of the fiber shall be such that the cabled fiber bandwidth shall be greater than 160 mhz-Km at 850 nm and greater than 500 Mhz-Km at 1300 nm when tested in accordance with EIA 455-51 (Pulse Distortion) or EIA 455-30 (Baseband Frequency Response).

The numerical aperture of the cable shall be 0.275 +/- 0.015 at 850 nm, (2-meter length of cable) in accordance with EIA 455-47.

MANUFACTURERS:

Subject to compliance with requirements, manufacturers offering products which may be incorporated in the work include, but are not limited to the following:

Alpha Communications.

AMP Netcon.

AT&T Network Systems.

Belden Div., Cooper Industries.

Brintec Corp.

E. I. duPont De Nemours and Co.

Guardian Products Div; General Cable Corp.

Houston Wire & Cable Corp.

ITT Corp.

Mohawk Wire & Cable Corp.

Northern Telecomm., Inc.

Pirelli Cable Corp.

Siecor Corporation.

Southwire Company.

Thomas and Betts Corp.

Times Fiber Communications, Inc.

CONDITION OF PRODUCTS:

Except as otherwise indicated, provide new electrical products, free of defects and harmful deterioration at the time of installation. Provide accessories and assembly devices recognized as integral parts of the product or required by governing regulations.

Unless otherwise indicated by the drawings or specifications or approved in writing, the materials and/or equipment furnished under this specification shall be the standard product of manufacturers regularly engaged in the production of such equipment, and shall be the manufacturer's standard design.

UNIFORMITY:

Where multiple units of a product are required for the electrical work, provide identical products by the same manufacturer without variations except for sizes and similar variations as indicated.

The fiber shall exhibit a zero (O) dispersion wavelength within the range of 1332nm to 1354nm. The zero (O) dispersion slope shall be less then 0.097 ps/nm-Km. Measurement shall be performed per EIA 455-168.

The cable shall be of all dielectric construction.

PART 3--EXECUTION

INSTALLATION:

General: Install the fiber optic cables, fiber optic cable splices, and connectors as indicated on the drawings, in accordance with the fiber optic cable manufacturer's written instructions, applicable requirements of NEC and NECA's "Standard of Installation," and in accordance with recognized industry practices to ensure products serve the intended functions.

A fiber optic connection box shall be installed at locations shown on the drawings. The fiber optic loop cable shall be looped as depicted on the contract drawings to provide adequate service length for future connections. The connection box shall be secured to the concrete manhole top or to a wall with concrete bolt anchors.

The fiber optic cable shall be installed in innnerduct for underground installation. This includes within the manholes. The innerduct shall be supported by the existing cable racks when available or by securing with suitable hardware to the concrete walls or ceiling. The support spacing shall be as required by NEC for nonmetallic raceways.

The innerduct shall meet V-2 and V-0 fire rating when tested to the underwriter's laboratories test 94. The innerduct shall be ribbed and have a super slippery silicon impregnated core and shall have a pull cord installed. The innerduct shall have an inner diameter of 1 inch. The innerduct shall be Durathane fire retardant polyethylene innerduct as manufactured by Duraline Corporation or approved equal.

No splices shall be allowed in the fiber optic cable except in the connection boxes. When it is necessary to splice the loop cable because the length of cable is not adequate to reach the next manhole or equipment location, all fibers shall be spliced unless a service cable is to be spliced at this location. All fibers which are not required for the service cable shall be spliced to the continuation loop cable.

At designated locations as shown on the construction drawings service cables shall be spliced into the cable. The designated fibers shall be separated from the loop fiber optic cable. All other fibers in the fiber optic loop cable shall be left continuous within the connection box. All fiber optic cables shall extra cable coiled within the junction box as shown on the contract drawings regardless of whether or not the cables are spliced, to provide adequate service length for changes which may be required in the future.

At the equipment locations a prefabricated connector assembly (pigtail) shall be spliced onto the designated fibers.

The fiber optic cable splices shall be accomplished with the use of a fusion splice instrument. The splice shall be done according the instructions provided by the manufacturer of the fusion splice instrument.

The fusion splice shall be accomplished by properly trained fusion splice operator. The operator must demonstrate his qualification by performing a minimum of ten splices on site in the environment in which the splices will be made and having the loss tested with the fiber optics test instrument.

If more than one splice exhibits more than 0.25 dB of insertion loss the operator shall not be considered properly trained.

All fiber optic splices shall be protected in splice trays design to protect fiber optic cable splices. These shall be Siecor metal tray part number M67-041 or approved equal.

FIBER OPTIC CABLE INSTALLATION:

The fiber optic cable shall be installed to meet the recommendations of the cable manufacturer. The pulling force applied to the cable shall not exceed the force stated by the cable manufacturer as the maximum force applied during installation. The bending of the fiber optic cable during installation shall not be less minimum bend radius and specified by the fiber optic cable manufacture but in no case shall be less than 12 inches for installation or 8 inches long term. Long gentle bends of the conduit is required on conduit runs. Pull box may be installed in order that this minimum bend radius may be met. See Section 16110 for conduit bending requirements.

Fiber Optic Cable Connector: The fiber optic connector shall be type "ST".

Exterior Pull Box: Exterior mounted pull boxes shall be NEMA Type 3R. The size shall be selected to meet the bend radius of the cable.

Interior Pull Box: Interior mounted pull boxes shall be NEMA Type 1. The size shall be selected to meet the bend radius of the cable.

Fiber Optic Connection Box: The fiber optic connection box shall be a NEMA 4X, 24 inch by 24 inch by 6 inch box with hinged cover with back plate. It shall be Hoffman A-24H24BLP with A-24P24 or approved equal.

FIBER OPTIC CABLE TERMINATION:

The fiber optic cable shall be terminated at each equipment location with an "ST" connector. The connector shall be installed by fusion splicing of commercially available pigtails. The fiber optic pigtails shall be Siecor JOO251A4--OO-OO3 or approved equal. Prior to separating the fibers for termination, securely clamp the fiber optic cable to the enclosure. Leave one inch of outer jacket prior to separating the fibers. For locations where the fibers must be separated to enter from two direction into a remote microphone or remote annunciator, secure the fiber optic cable in the pull box adjacent to the enclosure.

FIBER OPTIC CABLE LOSS:

The end to end path loss for any of the fiber optic signal paths shall be 6 dB maximum. The maximum allowed loss for a single splice shall be 0.25 dB. The loss shall be tested per EIA 455-31.

SUBCONTRACTOR RESPONSIBILITY:

The Subcontractor shall provide all tools and equipment needed to complete the installation, termination, and testing of the fiber optic cable. This shall include the installation of connectors at the end of each fiber section. The Subcontractor shall make certain that the signal loss is less than the maximum allowed.

All tools purchased for this Subcontract shall be turned over to the Operating Contractor at the completion of the Subcontract.

The Subcontractor shall make certain that the use of installation devices and test equipment are operated as directed by the equipment manufacturer. Training in the use of the instrumentation which is to be used in the installation, termination, and testing of the fiber optic cable is required. The Subcontractor shall certify that each person who will perform a fusion splice or test the transmission properties of the fiber optic cable has been properly trained in the use of the equipment used. The vendor data submittal shall state the type of training, the date, and the trainer.

QUALITY CONTROL TESTING:

Subcontractor Supplied Testing: The Subcontractor shall test each fiber optic communication segment to verify proper operation. The signal path loss shall be measured with a calibrated light loss measurement device.

FIELD QUALITY CONTROL:

Surveillance will be performed by the Contractor's Representative to verify compliance of the work to the drawings and specifications.

END OF SECTION 16123

SECTION 16124--INSULATED MEDIUM VOLTAGE CABLE, AND CONNECTORS

PART 1--GENERAL

SUMMARY

This section includes single and multiple conductor cables, cable splices, terminations and accessories for medium voltage cables.

Section Includes: Work includes, but is not limited to:

Provide and install 15 kV cable and connectors of the types specified herein and as shown on the drawings.

REFERENCES:

The following documents, including others referenced therein, form part of this Section to the extent designated herein. Unless otherwise indicated use the latest edition in effect as of the date of these specifications.

SUBMITTALS:

See Vendor Data Schedule.

The Subcontractor shall provide a completed pull sheet to the Contractor's Representative for signature prior to cable pulling. Signed pull sheets or copies thereof shall be in the possession of the cable installer during each cable pulling.

QUALITY CONTROL:

Regulatory Requirements (Codes and Standards): Comply with provisions of the following codes and standards unless otherwise specified herein.

Codes and Standards: See Section 16000, Electrical General Provisions.

Electrical Component Standard: Installation shall comply with NFPA 70 "National Electrical Code.

IEEE Compliance: Comply with applicable IEEE standards including C2 "National Electrical Safety Code".

UL Compliance: Cables and connectors shall each be listed and labeled by UL.

Single Source Responsibility: All medium voltage cable shall be the product of a single manufacturer.

Installer Qualifications: Engage an experienced Installer of medium-voltage electrical cable to perform the installation specified in this section. In addition, for the specific work of cable splicing and terminating, engage Installers who are experienced in cable splices for the specific types of cable and cable accessories specified in this Section.

Tester Qualifications: Engage a cable tester currently certified by NETA or National Institute for Certification in Engineering Technologies to supervise on site testing.

DELIVERY, STORAGE, AND HANDLING: Deliver medium-voltage cable on factory reels conforming to NEMA WC26. Store cable reels on elevated platform in a dry location. Cable ends shall be checked for water tight seals. Reel ends of cables shall be immediately resealed after cutting to eliminate intrusion of moisture. Cable jackets subject to ultra-violet degradation shall be stored indoors.

PART 2--PRODUCTS

MATERIALS:

MEDIUM-VOLTAGE CABLE:

General: Cable shall be single- and multi conductor types, with types and size as indicated on the drawings, and conforming to UL Standard 1072, "Medium Voltage Power Cables". Approved cable manufacturers are; Okonite Co., Rome Cable Co. AND Kerite.

Cable Type MV-90: Cable Type MV-90 shall be EPR insulated and shall conform to NEMA Standard WC8 (1CEA S-68-516) Ethylene - Propylene Rubber-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy unless otherwise shown on the drawings.

Conductors: Class B stranded, annealed copper.

Cable Jacket: select one [Chlorosulfonated polyethylene (hypalon).]
[Polyvinyl Chloride]

Metallic Shielding: Copper shielding tape, helically applied over semiconducting insulating shield.

Cable Voltage Ratings: [5 kV] [15 kV] phase-to-phase as shown on the drawings and in accordance with the referenced standard.

Insulation Thickness: Corresponding to 133% insulation level in accordance with the referenced standard unless shown otherwise on the drawings.

Three-Conductor Cable Assembly: Three insulated, 15 kV shielded conductors as shown on the drawings. The conductors shall be cabled together with grounding conductor(s), sized as indicated, with fillers to make round, and secured with an overall jacket.

Circuit Identification: Color-coded tape(Black-Phase A, Red-Phase B, Blue-Phase C) shall be applied under the metallic shielding for [5 kV] [15 KV] multi conductor cable in all manholes, hand holes and pull boxes. Cable circuit numbers shall identify the cable at no less then every 100 ft. of exposed cable and at each entry to a ductbank system.

SPLICING AND TERMINATING PRODUCTS:

General: Comply with the following standards:

IEEE 48: "IEEE Standard Test Procedures and Requirements for High-Voltage Alternating Current Cable Terminations."

IEEE 400: "Guide for Making High-Direct-Voltage Tests on Power Cable Systems in the Field."

IEEE 404: "Standard for Power Cable Joints."

IEEE 592: "Standard for Exposed Semiconducting Shields on Premolded High-Voltage Cable Joints and Separable Insulated Connectors."

UL 486A: "Wire Connectors and Soldering Lugs for Use with Copper Conductors."

Types: Compatible with the cable materials.

Connectors: Compression type as recommended by cable or splicing kit manufacturer for the application.

Splicing and Terminating Kits: As recommended by the manufacturer in writing for the specific sizes, ratings, and configurations of cable conductor, splices, and terminations specified. Kits shall contain all components required for a complete splice or termination including detailed instructions and shall provide insulation equivalent to the insulation class of the cable it connects. Splices shall be made with standard splicing kits and shall be of the following manufactures: Thomas and Betts, Raychem heat shrink, or approved equal.

Conductor Terminations, General: Comply with Class 1, 2, or 3 of IEEE Standard 48, as indicated. Insulation class shall be equivalent to that of the cable upon which they are installed. Terminations for shielded cables shall include a shield grounding strap. Class 2 terminations and nonshielded cable terminations shall include an effective moisture seal for the end of the insulation whether or not this item is included in terminations kits. Seal shall be cold shrink rubber sleeve, or heat shrink sleeve as recommended by the kit manufacturer.

Termination kits shall be performance tested for compliance with IEEE Standard 48 and shall be of the following types:

Class 1 Termination for Outdoor Shielded Cable: Heat-shrinkable type with heat-shrinkable inner stress control and outer non-tracking tubes, multiple molded non-tracking skirt modules, and compression-type connector.

Class 1 Termination for Indoor Shield Cable: Furnished as a kit with stress relief tube, non-tracking insulator tube, shield ground strap, compression-type connector, and end seal.

Separable Insulated Connectors: Modular system, complying with IEEE Standard 386, "Separable Insulated Connectors for Power Distribution Systems above 600V". System shall consist of disconnecting, single-pole cable terminators and matching stationary, plug-in, dead-front terminals. System components shall be designed for the system voltage and for sealing against moisture and shall conform to the following:

Cable Termination at Equipment: (Such as transformers or switchgear): Elbow-type terminators that mate with bushing terminals in the equipment.

Load-Break Cable Terminators: Elbow-type units with 200 ampere load make/break and continuous current rating as shown on the drawings. Each terminator shall be coordinated with insulation diameter and conductor size and material of cable being terminated. Terminator body shall have capacitively coupled test point. Load Break elbows shall be sized to mate with existing sectionalizing Terminal as shown on drawings.

Dead-Break Cable Terminators: Elbow-type unit with 600 ampere continuous current rating designed for de-energized disconnecting and connecting coordinated with insulation diameter and conductor size and material of cable being terminated. Include capacitively coupled test point on terminator body.

Grounding Kit: Grounding kit shall include jumpered elbows, portable feed-through accessory units, protective caps, test rods suitable for concurrently grounding three-phases of feeders, and carrying case.

PART 3--EXECUTION

EXAMINATION: Examine raceways, cable trays, pull boxes, manholes, junction boxes, and other cable installation locations for cleanliness of raceways, minimum bending radii of cables, and conditions affecting performance of cable installation. Pull a mandrel through raceways to check for raceway blockages and cleanliness. Do not proceed with cable installation until satisfactory conditions have been achieved.

INSTALLATION:

General: Install cable accessory items in accordance with manufacturer's written instructions and as indicated. Do not exceed manufacturer's approved maximum pulling tensions and sidewall pressure values.

INSTALLATION OF CABLES:

Install cable in accordance with manufacturers written instructions and at locations shown on the drawings. Cables installations which deviate from the drawings i.e., pull lengths or pull direction etc. shall be calculated and submitted by the Subcontractor for written approval.

Pull Conductors Simultaneously: Conductors in the same raceway shall be pulled simultaneously. Use UL-listed and manufacturer-approved pulling compound or lubricant where necessary.. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values for multi conductor installation. Where only single cable maximum values are provided by the manufacturer use only 70% of the maximum tension and sidewall pressure value.

Cable Pull Sheets: Each individual cable installation shall be identified on a "Cable Pull Sheet(s)". The pull sheet shall completely identify the cable type, manufacturer's reel number, length, number of splices, type pulling rope, type lubricant, type cable attachment, along with a sketch of the pull.

Use Pulling Means: Use pulling means including, fish tape, cable, rope, and basket weave wire/cable grips that will not damage cables or raceways. Do not use rope hitches as the pulling attachment to cable.

Install Exposed Cable: Install exposed cable parallel and perpendicular to surfaces of exposed structural members and follow surface contours where possible.

In Manholes: In manholes, hand holes, pull boxes, and junction boxes, train cables around walls from entry to exit and support cables with racks, framming channel, etc., at intervals adequate to prevent sag.

Cable loops are required a minimum of each 600 ft of cable length to allow for cable movement and minimize cable stress. Loop cable around manhole interior from entrance to exit. Train cables as to not block the ladder access. Do not exceed the cable manufacturer bending radius.

INSTALLATION OF TERMINATIONS:

Install Terminations: Install terminations at ends of conductors and seal multi conductor cable ends with standard kits. Conform to manufacturer's written instructions. Comply with classes of terminations indicated. Cables not terminated within 3 hours shall be sealed to eliminate the entrance of moisture.

Tighten Electrical Connectors and Terminals: Tighten electrical connectors and terminals in accordance with manufacturer's torquing requirements. If requirements are not indicated, tighten connectors and terminals to comply with tightening torques specified in UL 486A.

INSTALLATION OF CABLE ACCESSORIES:

Arc-Proofing: Arc-proofing shall be applied to medium voltage cables as indicated or where not protected by conduit, or termination materials. Apply arc proofing tape as recommended by the manufacturer.

GROUNDING: Ground shields of shielded cable at terminations, splices, and separable insulation connectors. Ground metal bodies of terminators, splices, cable and separable insulated connector fittings, and hardware in accordance with manufacturers written instructions.

IDENTIFICATION: Identify cable in accordance with Section 16195, Electrical Identification.

QUALITY CONTROL TESTING

Subcontractor Supplied Testing Procedure:

Test Objectives: To ensure cable installation, including cable accessories, is operational within industry and manufacturer's tolerances, is installed in accordance with Contract Documents, and is suitable for energizing.

Procedures: Comply with International Electrical Testing Association (NETA) standard, "Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems", Section 7.3.2, Cables, Medium Voltage and IEEE 400. Upon satisfactory completion of tests, attach a label identified by cable pull sheet number to tested components.

Report Form: Test reports shall be identified by reference to individual cable pull sheet(s).

Tests: After the termination kits are unstalled, but prior to terminating at the equipment, the Subcontractor will perform cable testing. Coordinate the testing with the Operating Contractors Power Management group.

Test Report: Test reports shall be contained with and become part of the cable pull sheet. Cable pull sheets shall be in the possession of the cable tester at the test site during each test.

The Subcontractor shall maintain a written record of observations and tests, report defective materials and workmanship, and retest corrected defective items. Subcontractor shall submit written reports to the Contractor Representative.

The Contractor's Representative, shall be informed of all cable test a minimum of 72 hrs in advanced of any cable testing. The Contractor Representative shall witness or waive the right to witness field tests and inspect the installation to determine compliance with the specifications and drawings.

If any conductor in a pull group fails the test then all conductors in that pull group shall be removed and replaced at the Subcontractors expense.

Contractor Inspection: Surveillance will be performed by the Contractor's Representative to verify compliance of the work to the drawings and specifications.

END OF SECTION 16124

SECTION 16160--PANELBOARDS

PART 1--GENERAL

WORK DESCRIPTION:

Provide and install distribution and power panelboards of sizes, ratings, materials, and types as shown on the panel schedules. Panelboards shall be equipped with thermal-magnetic, molded case circuit breakers of trip ratings as shown on the panel schedules.

WORK INCLUDED: Work includes, but is not limited to:

Furnishing and installing the panelboards shown on drawings and specifications including the enclosures, bus bars, breakers, covers, circuit directories, and wire labeling as required. Terminate all conductors inside enclosures. All panelboards, especially those where knockouts have been pulled or holes sawed in the enclosure, shall be thoroughly cleaned and vacuumed to ensure all metal scraps and shreds are removed before the cover is installed.

SUBMITTALS:

See Section 01300, Submittals and the Vendor Data Schedule for submittal requirements.

PART 2--PRODUCTS

MATERIALS

Bussing Assembly and Temperature Rise: All bussing shall be copper. Panelboard bus structure and main lugs or main breaker shall have current ratings as shown on the panelboard schedule. Such ratings shall be established by heat rise tests with maximum hot spot temperature on any connector or bus bar not to exceed 50 • C rise above ambient. Heat rise tests shall be conducted in accordance with Underwriters Laboratories Standard UL 67. The use of conductor dimensions will not be accepted in lieu of actual heat tests. All panelboards shall have ground and neutral bus installed.

Circuit Breakers: Circuit breakers shall be equipped with individually insulated, braced and protected connectors. The front faces of all circuit breakers shall be flush with each other. Large, permanent, individual circuit numbers shall be affixed to each breaker in a uniform position. Tripped indication shall be clearly shown by the breaker handle taking a position between "ON" and "OFF". Provisions for additional breakers shall be such that no additional connectors will be required to add breakers.

Integrated Equipment Short Circuit Rating: Each panelboard, as a complete unit, shall have a factory established short circuit current rating equal to or greater than the integrated equipment rating shown on the panelboard schedule or on the drawings. This rating shall be

established by the factory testing with the overcurrent devices mounted in the panelboard. The short circuit tests on the overcurrent devices and on the panelboard structure shall be made simultaneously by connecting the fault to each overcurrent device with the panelboard connected to its rated voltage source. Method of testing shall be per Underwriters Laboratories Standard UL 67. The source shall be capable of supplying the specified panelboard short circuit or greater. Factory testing of panelboard overcurrent devices for short circuit rating only while individually mounted is not acceptable. Also, testing of the bus structure by applying a fixed fault to the bus structure alone is not acceptable. Panelboards shall be factory marked with their maximum short circuit current rating at the supply voltage and shall be UL listed.

Cabinet: Panelboard assembly shall be enclosed in a steel cabinet. The rigidity and gauge of steel shall be as specified in UL Standard 50 for cabinets. The size of wiring gutters shall be in accordance with UL Standard 67. Cabinets shall be equipped with latch and tumbler-type lock on door of trim. Doors over 48" long shall be equipped with three-point latch and vault lock. All locks shall be keyed alike. Endwalls shall be removable. Finish shall be gray backed enamel electrodeposited over clean phosphatized steel. A circuit directory frame and card with a clear plastic covering shall be provided on the inside of the door. The directory shall be typed by the Subcontractor and shall indicate the area and function served by each breaker.

Safety Barriers: The panelboard interior assembly shall be dead front with the panelboard front removed. Main lugs or main breakers shall have barriers on five sides. The barrier in front of the main lugs shall be hinged to a fixed part of the interior. The end of the bus structure opposite the mains shall have barriers.

UL Listing: Panelboards shall be listed by Underwriters Laboratories and shall bear the UL label. When required, panelboards shall be suitable for and marked for use as service equipment in orange letters.

PART 3--EXECUTION

INSTALLATION:

Install panelboards as indicated on the drawings and in accordance with manufacturer's written instructions, applicable requirements of NEC and National Electrical Contractors Association's "Standard of Installation," and complying with recognized industry practices to ensure that products serve intended functions.

Provide electrical connections within enclosures.

QUALITY CONTROL TESTING:

Subcontractor Supplied Testing: Visual inspection to determine that equipment installation conforms to NEC, these specifications and the drawings.

FIELD QUALITY CONTROL:

Surveillance will be performed by the Contractor's Representative to verify compliance of the work to the drawings and specifications.

END OF SECTION 16160

SECTION 16195--ELECTRICAL IDENTIFICATION

PART 1--GENERAL

SUMMARY:

Section Includes: Work includes, but is not limited to:

The subcontractor shall provide and install labels and identification as specified herein and on the drawings. See electrical drawings for equipment identifiers.

Install labels on all electrical and related equipment including wires, cables, J-Boxes, switches, receptacles, panels, disconnects, MCC's, PCC, and load centers.

Related Sections:

16000	Electrical General Provisions
16109	Switches, Receptacles and Wall-Plates
16110	Electrical Raceways
19116	Precast Manholes and Handholes
16120	Cable, Wire, Connectors and Miscellaneous Devices
16160	Panel Boards
16360	Disconnect Switches
16361	Medium Voltage Load Interrupter Switchgear

SUBMITTALS:

No Vendor Data is required for this section unless an "or-equal" item is proposed.

QUALITY CONTROL:

Regulatory Requirements (Codes and Standards): Comply with provisions of the following codes and standards unless otherwise specified herein.

Electrical Component Standard: Components and installation shall comply with NFPA 70 "National Electrical Code."

ANSI Compliance: Comply with requirements of ANSI Standard A13.1, "Scheme for the Identification of Piping Systems," with regard to type and size of lettering for raceway and cable labels.

PART 2--PRODUCTS

MATERIALS:

Adhesive Marking Labels for all Raceway and Metal-Clad Cable: Pre-printed flexible, self-adhesive labels with legend, identifying system type, or voltage and phase.

Wire and Cable Designation Tape Markers: Self-adhering, oil and moisture resistant, vinyl labels covered with clear heat shrink tubing. Letters shall be typed on in black, non-smear ink. Hand lettered labels shall not be used. Engraved identification tags may also be used.

Brass, Steel, or Aluminum Tags: Metal tags with stamped legend, punched for fastener. Dimensions: minimum 2" x 2" x 19 gauge with 1/4 in. radius corners and 3/16 in. hole for fastener.

Brass and Steel Labels: 0.31 to 0.50 in. thick with 1/4 in. radius corners, 3/16 in. holes in corners, and black engraving.

Engraved, Plastic-Laminated Labels, Tags, Signs, and Instruction Plates: Engraving stock melamine plastic laminate, 1/16 in. minimum thick for signs up to 20 sq. in., or 8 in. in length; 1/8 in. thick for larger sizes. Engraved legend and punched for mechanical fasteners.

Exterior Metal-Backed Butyrate Warning and Caution Signs: Weather-resistant, non-fading, pre-printed cellulose acetate, butyrate signs with 20 gauge, galvanized steel backing, with colors, legend, and size appropriate to the location. Provide 1/4 in. grommets in corners for mounting.

Fasteners for Plastic-Laminated and Metal Signs: Self-tapping stainless steel screws or number 6/32 galvanized steel machine screws with nuts, flat washers, and lock washers. All signs and labels shall be glued into place using clean GE Silicone II adhesive. Duplex receptacles and light switches shall be glued on only. All labels larger than 1" high x 2" long shall be glued and screwed on.

PART 3--EXECUTION

INSTALLATION:

Install Equipment/System Circuit/Device Identification as follows:

Apply equipment identification labels of engraved plastic-laminate on all electrical equipment including the central or master unit of each electrical system and each sub breaker or controller. This includes medium and low voltage power distribution/communication/signal/alarm systems. Text shall match terminology and

numbering of the Contract Documents and shop drawings. Apply labels for each unit of the following categories of electrical work:

- Panelboards, electrical cabinets, and enclosures
- Access doors and panels for concealed electrical items
- Motor starters and MCC main cabinets
- Power transfer equipment
- Contractors
- Control devices
- Components, wires and cables
- Disconnect and safety switches
- Transformers
- Fire alarm control panel
- Receptacles
- Light switches
- Light fixtures
- Power Control Centers (PCC) and each sub breaker.

Apply circuit/control/item designation labels of engraved plastic laminate for panels, disconnect switches, breakers, motor controllers, motor control centers, substation and load centers and similar items for power distribution and control components above. For panelboards, provide and install a framed, typed circuit schedules (directory) with explicit description and identification of items controlled by each individual breaker. Furnish a copy of the panel directory to the Contractor.

Install labels at locations indicated and at locations for best convenience of viewing without interference with operations and maintenance of equipment.

IDENTIFICATION AND LABELING OF ELECTRICAL EQUIPMENT:

Background and legend colors for electrical equipment labels shall be as specified in Table I.

Table I. Electrical Equipment Label Colors

Power System Classification	Power System Designator	Background Color	Legend Color
Normal	N	black	white
Standby	S	yellow	black
Emergency	E	white	red
UPS	U	white	red
Regulated	R	same as source	same as source
Direct current	DC	black	white

Electrical equipment label and lettering size shall be as specified in Table II. If equipment size constraints make the specified label size impractical, the label and lettering size will be large as possible for that particular equipment application.

Table II. Electrical Equipment Label Sizes

Power Equipment Classification	Label Height (minimum)	Lettering Height First Line	Lettering Height Subsequent Lines
Primary Distribution Equipment	2 1/2 inch	3/4 inch	3/8 inch
Secondary Power Distribution Switches	1 inch	3/8 inch	1/4 inch
Disconnect Switches	1 inch	3/8 inch	1/4 inch
Power Distribution Panels	1 inch	1/2 inch	1/4 inch
Power Distribution Transformers	2 inch	1/2 inch	1/4 inch
PCC/MCC Switchgear Switchboards	2 inch	3/4 inch	3/8 inch
Power Receptacles	3/8 inch	3/16 inch	N/A

Electrical power distribution equipment labels shall include the following as applicable:

1. The properly assigned identifier (as shown on drawings)

2. The noun name or function description.

3. Are designation on system designator as assigned by ICPP. See Reference drawing _____.

4. Equipment inventory number.

5. The voltage and the number of phases.

6. The power source (fed from) equipment identifier, the circuit number (if applicable), and building in which power source is located if different from equipment location.

7. Transformer and disconnect switch labels shall contain the destination (fed to) power equipment identifier fed by the transformer secondary or disconnect switch.

Example Panel Labels:
S-LP-WL-3901
LIGHTING PANEL, 408/277V, 3 PHASE
FED FROM: PANEL EP-2, CKT 2, WMF-603
N-PP-WL-3901
POWER PANEL, 480/277V, 3 PHASE
FED FROM: TRANSFORMER N-XFR-3901

Example Transformer Label: N-XFR-WL-3901
TRANSFORMER
FED FROM: SECTIONALIZER ST-2
FEEDS: PANEL N-PP-3901

Example Disconnect Label: N-DS-WL-3901
DISCONNECT SWITCH
FED FROM: PANEL N-PP-3901, CKT 4
FEEDS: HEATER HV-EHTR-3903

Labels are to be made from materials that are compatible with the application. Brass or stainless steel shall be used where shown on the drawings.

The equipment label(s) shall be located on the front of electrical equipment in as visible a location as possible.

Separate labels shall be utilized for the identification of cautions or dangers required by code and as designated on the drawings.

LABELING OF LIGHT SWITCHES AND RECEPTACLES:

All light switches and single-phase receptacles shall be labeled to identify the source power panel, circuit number, and voltage. Glue all labels to cover using construction adhesive GE Silicone II or equal.

Example Light Switch and Single Phase Receptacle Label: N-LP-3901 CKT 2, 120V

All three phase power/welding receptacles labels shall include identifier, voltage, source power panel, and circuit number.

Example Three Phase Receptacle Label:
N-RCP-3901, 480V
FED FROM: N-PP-3901, CKT 4

The label shall be engraved plastic laminate. The label shall be attached securely on or at each receptacle.

Label and lettering sizes shall be as specified in Table II.

Labeling shall be consistent with the one line, facility drawings, and panel schedules.

IDENTIFICATION AND LABELING OF FIRE ALARM AND SUPERVISORY EQUIPMENT:

Label all fire alarm and supervisory equipment per Specification 16721--Fire Alarm and Supervisory System.

IDENTIFICATION AND LABELING OF CIRCUITS, CABLES, AND WIRE:

Each individual circuit breaker in a panelboard shall be clearly identified by a circuit number appropriate to the individual panelboard. All circuits, breakers, or spaces that are spare, blank, or utilized for power distribution shall be properly identified on the panel legend provided by the subcontractor or manufacturer. The method of identification shall be as follows:

Panelboard Breakers: Single pole breakers shall take the single pole space number, double pole breakers shall take the first number of the two single spaces that it occupies, and the three pole breakers shall take the first number of the three single spaces that it occupies. For example, a three-pole breaker in spaces 1, 3, and 5 would be labeled breaker No. 1. A two-pole breaker in spaces 7 and 9, would be labeled No. 7. A single pole breaker in space 11 would be numbered No. 11. A type written circuit directory shall be installed in each panel and a copy furnished to the Contractor.

Switchgear Cubicles: Label individual switchgear cubicles/cells.

Conductors: All conductor identification shall include the panel identifier, the circuit identification number from the panel with the destination equipment identifier and the voltage.

> Example Conductor Label: A conductor from S-PP-2301, circuit No. 4, to S-DS-3901 would be identified with the identification number S-PP-2301-4/S-DS-3901, 120V.
>
> Conductors to 120V light switches and 120V duplex receptacles do not need to be labeled.
>
> Each conductor or cable shall also be clearly identified and labeled in all electrical pull boxes or junction boxes. Engraved, laminated plastic identification tags are acceptable for this purpose when attached to each conductor.

All exposed cables used for power distribution or instrumentation shall be labeled with the assigned identification number no less than every 100 ft for the total length of the cable. Individual conductors used for overhead power distribution shall be labeled at each termination point.

Below Grade Power Circuit Identification: Securely fasten identifying tags to cables, feeders, and power circuits in vaults, pull boxes, and junction boxes. Tags shall have engraved legend to correspond with designations in specifications and on drawings. Attach tags with approximately 55-lb test monofilament line or one-piece self-locking nylon cable ties. Tag cables at each entry and exit of the manhole or once in a pull box or J-Box.

Conductor Color Coding: Provide color coding for secondary service, feeder, and branch circuit conductors throughout the project secondary electrical system as specified in Section 16120, Cable, Wire, Connectors and Miscellaneous Devices.:

Use conductors with color factory-applied the entire length of the conductors except as follows:

The following field-applied color-coding methods may be used in lieu of factory-coded wire for sizes larger than No. 10 AWG.

Apply colored, pressure-sensitive plastic tape in half-lapped turns for a distance of 6 in. from terminal points and in boxes where splices or taps are made. Apply the last two laps of tape with no tension to prevent possible unwinding. Use 1 in. wide tape in colors as specified. Yellow phase tape shall consist of two separate bands at each application point in order to avoid confusion with white, gray, or orange after aging. Do not obliterate cable identification markings by taping. Tape locations may be adjusted slightly to prevent such obliteration. All wire markers and phase tape shall be covered by clear heat shrink sleeving.

Sequence of Work: Where identification is to be applied to surfaces that require finish, install identification after completion of finish work.

CONDUIT LABELS:

Conduits shall be identified by a label attached parallel or encircling the conduit with a legend of the conductor characteristics including: highest voltage level contained within the conduit, AC or DC current, number of phases, and service type (FA for Fire Alarm, ENS for Emergency Notification, VP for Voice Paging, EVAC for Evacuation), if applicable.

Example Conduit Label: 120V, AC, 1 Ph, FA.

Conduit labels shall be color-coded as specified in Table III:

Table III: Conduit Label Colors

Power Type	Background Color	Lettering Color
Normal Power	Orange	Black
Standby Power	Yellow	Black
Emergency Power	White	Red

Labeling Size and Placement: The minimum letter height of content and identification labels of raceways and conduit shall be as specified in Table IV below. A letter size of at least one half the trade diameter is recommended for conduit. The label shall be as long as required to display the specified information.

Table IV. Conduit Label Sizes

Raceway or Conduit Size (inches)	Minimum Height of Lettering (inches)
3/4 to 1 1/4	1/2
1 1/2 to 2	3/4
2 1/2 to 6	1 1/4

Note: The size refers to the nominal diameter for conduit or the width of the raceway or cable tray.

Exposed raceways and conduits shall be labeled within 3 ft of the power source and adjacent to process equipment; adjacent to each side of any penetration through floors, walls, or bulkheads. Labels shall be placed at intervals not to exceed 20 ft on straight runs of conduit. Raceways and conduit shall be labeled at least once in each room through which they pass. Labels shall be located to facilitate ease of identification. Conduit in ceiling space above suspended ceilings shall be labeled.

High Voltage Feeders:

Identify high-voltage feeder conduits (over 600 V) by words "DANGER-HIGH VOLTAGE" in black letters 2 in. high, stenciled at 10 ft intervals over continuous painted orange background.

The following areas shall be identified:

On wall surfaces directly external to conduits run concealed within wall.

On entire surface of exposed conduits.

Apply identification to areas as follows:

Clean surface of dust, loose material, and oily films before painting.

Prime surfaces: For galvanized metal, use single-component acrylic vehicle coating formulated for galvanized surfaces. For concrete masonry units, use heavy-duty acrylic resin block filler. For concrete surfaces, use clear alkali-resistant alkyd binder-type sealer.

Apply one intermediate and one finish coat of orange silicone alkyd enamel.

Apply primer and finish materials in accordance with manufacturer's instructions.

WARNING, CAUTION, AND INSTRUCTION SIGNS:

Identify Junction and Connection Boxes: Code-required caution sign for boxes shall be pressure-sensitive, self-adhesive label indicating system voltage in black, pre-printed on orange background. Install on outside of box cover. Install a plastic laminate engraved label on box covers with identity of contained circuits. Use pressure-sensitive plastic labels at exposed locations and similar labels or tags at concealed boxes.

Apply warning, caution, and instruction signs and stencils as follows:

Install warning, caution, and instruction signs where required by NEC, where indicated on the drawings, and where required to assure safe operations and maintenance of electrical systems and of the items to which they connect. Install engraved plastic-laminated instruction signs with instructions or explanations needed for system or equipment operation. Install butyrate signs with metal backing for outdoor items.

LABELING OF MANHOLES AND HANDHOLES:

IDENTIFICATION LABELS:

All manholes and handholes shall have the properly assigned identifier indicated on the cover see drawings for identifiers.

FIELD QUALITY CONTROL:

Site Tests: The Subcontractor or his agents shall perform the following tests:

Contractor Inspection: Surveillance will be performed by the Contractor's Representative to verify compliance of the work to the drawings and specifications.

END OF SECTION 16195